We claim:

1. An interlace-to-progressive scan conversion system, comprising:

a prefilter having a prefiltered signal as an output;

a motion estimator having the prefiltered signal as input and a motion-corrected signal as an output;

an adaptive filter having the prefiltered signal and the motion-corrected signal as inputs.

2. The interlace-to-progressive scan conversion system of claim 1, wherein the prefilter is a line averaging filter.

3. The interlace-to-progressive scan conversion system of claim 2, wherein the prefilter is a spatial line averaging filter.

4. The interlace-to-progressive scan conversion system of claim 1, wherein the motion estimator is adapted to perform a 3-D recursive search.

5. The interlace-to-progressive scan conversion system of claim 1, wherein the motion estimator is adapted to perform motion vector correction.

6. The interlace-to-progressive scan conversion system of claim 1, wherein the motion estimator is adapted to perform a block erosion process.

7. The interlace-to-progressive scan conversion system of claim 1, wherein the adaptive filter comprises a median filter.

8. The interlace-to-progressive scan conversion system of claim 1, wherein the adaptive filter comprises a line averaging filter.

9. The interlace-to-progressive scan conversion system of claim 1, wherein the adaptive filter comprises an adaptive recursive filter.

10. The interlace-to-progressive scan conversion system of claim 1, wherein the adaptive filter comprises a time recursive filter.

11. The interlace-to-progressive scan conversion system of claim 1, wherein:

the adaptive filter comprises a three-stage adaptive recursive filter, wherein:

a first stage comprises a function that selects between using static pixels data and moving pixels data from a next field;

a second stage comprises a function that selects a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and

a third stage comprises a function that combines an intra-field interpolation with the more valid set of data selected by the second stage.

12. The interlace-to-progressive scan conversion system of claim 11, wherein the prefilter comprises a spatial line average filter.

13. The interlace-to-progressive scan conversion system of claim 11, wherein the motion estimator comprises a 3-D recursive search sub-component.

14. The interlace-to-progressive scan conversion system of claim 11, wherein the motion estimator comprises a motion vector correction sub-component.

15. The interlace-to-progressive scan conversion system of claim 11, wherein the motion estimator comprises a block erosion sub-component.

16. An interlace-to-progressive scan conversion system, comprising:

a spatial line averaging prefilter having a prefiltered signal as an output;

a motion estimator having the prefiltered signal as input and a motion-corrected signal as an output, the motion estimator comprising:

a 3-D recursive search sub-component;

a motion vector correction sub-component;

a block erosion sub-component;

a three-stage adaptive recursive filter, wherein:

a first stage comprises a function that selects between using static pixels data and moving pixels data from a next field;

a second stage comprises a function that selects a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and

a third stage comprises a function that combines an intra-field interpolation with the more valid set of data selected by the second stage.

17. The interlace-to-progressive scan conversion system of claim 16, wherein the 3-D recursive search sub-component resolves motion vectors to at least quarter-pixel accuracy.

18. The interlace-to-progressive scan conversion system of claim 17, wherein the look-up table consists of:

$$US_n = \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 2 \end{pmatrix}, \begin{pmatrix} 0 \\ -2 \end{pmatrix}, \begin{pmatrix} 3 \\ 0 \end{pmatrix}, \begin{pmatrix} -3 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ \frac{1}{4} \end{pmatrix}, \begin{pmatrix} 0 \\ -\frac{1}{4} \end{pmatrix}, \begin{pmatrix} \frac{1}{4} \\ 0 \end{pmatrix}, \begin{pmatrix} -\frac{1}{4} \\ 0 \end{pmatrix} \right\}$$

19. The interlace-to-progressive scan conversion system of claim 16, wherein the motion estimator includes a bilinear interpolator.

20. The interlace-to-progressive scan conversion system of claim 19, wherein a value of a first estimator is set to a value of a second estimator if:

$$e(\overline{MV}_a, \overline{X} - \overline{SMV}_a, t) > e(\overline{MV}_b, \overline{X} - \overline{SMV}_b, t) + Th$$

and wherein the value of the second estimator is set to the value of the first estimator if:

$$e(\overline{MV}_b, \overline{X} - \overline{SMV}_b, t) > e(\overline{MV}_a, \overline{X} - \overline{SMV}_a, t) + Th$$

where Th is a fixed threshold.

21. The interlace-to-progressive scan conversion system of claim 16, wherein an error function of the motion estimator includes penalties related to a length of the difference vector between a given candidate vector and a plurality of neighboring vectors.

22. The interlace-to-progressive scan conversion system of claim 21, wherein the error function is defined by:

$$e(\overline{C}, x, y, t) = \sum_{x \in B(x,y,t)} \left| F(x,y,t) - F(x - C_x, y - C_y, t - T) \right| + \alpha \cdot \left\| \overline{U}(x,y,t) \right\|$$

23. The interlace-to-progressive scan conversion system of claim 21, wherein the motion estimator assumes that a motion vector for an object between a previous field and a current field is the same as a motion vector for the object between the current field and a next field.

24. The interlace-to-progressive scan conversion system of claim 23, wherein a motion vector error correction function is defined by:

$$\overline{MV}(x,y,t) = \begin{cases} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, & (e_m(x,y,t) \geq e_s(x,y,t)) \\ \overline{MV}(x,y,t), & (e_m(x,y,t) < e_s(x,y,t)) \end{cases}$$

where:

$$e_m(x,y,t) = \frac{\sum_{x \in X} |F(X) - F(C)| + \sum_{x \in X} |F(X) - F(D)|}{2}$$

$$e_s(x,y,t) = \frac{\sum_{x \in X} |F(X) - F(A)| + \sum_{x \in X} |F(X) - F(B)|}{2}.$$

and where ***A***, ***B***, ***C***, ***D***, and ***X*** are blocks containing ends of candidate motion vectors, ***X*** being in the current field, ***A*** and ***C*** being in the previous field, and ***B*** and ***D*** being in the next field.

25. The interlace-to-progressive scan conversion system of claim 23, wherein a motion vector error correction function is defined by:

$$\overline{MV}(x,y,t) = \begin{cases} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, & (e_m(x,y,t) \geq e_s(x,y,t)) \\ \overline{MV}(x,y,t), & (e_m(x,y,t) < e_s(x,y,t)) \end{cases}$$

where:

$$e_m(x,y,t) = \sum |F(C) - F(D)|$$

$$e_s(x,y,t) = \sum |F(A) - F(B)|$$

and where ***A***, ***B***, ***C***, ***D***, and ***X*** are blocks containing ends of candidate motion vectors, ***X*** being in the current field, ***A*** and ***C*** being in the previous field, and ***B*** and ***D*** being in the next field.

26. The interlace-to-progressive scan conversion system of claim 16, wherein a cost function is defined by:

$$\forall\ F(x,y,t) \in B(x,y,t):$$

$$D = \left|F(x,y,t) - F(x - MV_{x,}y - MV_{y},t-1)\right|$$

$$TD = TD + D$$

$$Diff = D - EstErr$$

$$EstErr = EstErr + (\delta + Diff));$$

$$Dev = Dev + \delta\left(\left|Diff\right| - Dev\right)$$

27. The interlace-to-progressive scan conversion system of claim 16, wherein the block erosion sub-component divides each block according to:

$$B(x,y,t) = \{(x,y) \mid X_x - X/2 \le x \le X_x + X/2 \wedge X_y - Y/2 \le y \le X_y + Y/2\}$$

wherein a vector $\overline{MV}(x,y,t)$ is assigned, into four sub-blocks $B_{i,j}(x,y,t)$

$$B_{i,j}(x,y,t) = \left\{(x,y) \mid X_x - (1-i)\cdot\frac{X}{4} \le x \le X_x + (1+i)\cdot\frac{X}{4} \wedge X_y(1-j)\cdot\frac{Y}{4} \le y \le X_y + (1+j)\cdot\frac{Y}{4}\right\}$$

and wherein the variables I and j take the values +1 and –1; wherein a vector $MV_{i,j}(x, y, t)$ is assigned to the pixels of each of the sub-blocks $B_{i,j}(x, y, t)$:

$$\forall(x,y) \in B_{i,j}(x,y,t): \overline{MV}_{i,j}(x,y,t) = \overline{MV}_{i,j}(\overline{X},t)$$

wherein:

$$\overline{MV}_{i,j}(\overline{X},t) = \text{med}\left[\overline{MV}\left(x + i\cdot X, y, t\right), \overline{MV}(\overline{X},t), \overline{MV}(x, y + j\cdot Y, t)\right]$$

wherein the median function is a median on the x and y vector components separately; and wherein a resulting vector is replaced by an original motion vector unless the resulting vector is equal to one of the three input vectors.

28. The interlace-to-progressive scan conversion system of claim 16, wherein the first stage selection function is given by:

$$F_n(x,y,t)=\begin{cases}F(x+MV_x(x,y,t),y+MV_y(x,y,t),t+1), & (D_m<D_s)\\ F(x,y,t+1), & (D_m\ge D_s)\end{cases}$$

where:

$$D_s=\sum_{k=-2}^{2}C_v(k)\cdot\left|F(x,y+k,t)-F(x,y+k,t+1)\right|$$

$$D_m=\sum_{k=-2}^{2}C_v(k)\cdot\left|F(x,y+k,t)-F(x-MV_x(x,y,t),y-MV_y(x,y,t)+k,t+1)\right|$$

29. The interlace-to-progressive scan conversion system of claim 16, wherein the third stage combining function is given by:

$$F_o(x,y,t)=\begin{cases}F(x,y,t), & (y \bmod 2=t \bmod 2)\\ \left(c_i\cdot F_i(x,y,t)\right)+(1-c_i)\left(c_p\cdot F_p(x,y,t)+(1-c_p)F_n(x,y,t)\right), & (\text{otherwise})\end{cases}$$

wherein c_i and c_p are adaptive coefficients ranging from 0 to 1; F_n is given by:

$$F_n(x,y,t)=\begin{cases}F(x+MV_x(x,y,t),y+MV_y(x,y,t),t+1), & (D_m<D_s)\\ F(x,y,t+1), & (D_m\ge D_s)\end{cases}$$

wherein intra-field interpolation is given by:

$$F_i(x,y,t)=\frac{F(x,y-1,t)+F(x,y+1,t)}{2}$$

and wherein backward data prediction is given by:

$$F_p(x,y,t) = F(x - MV_x(x,y,t), y - MV_y(x,y,t), t-1)$$

30. An interlace-to-progressive scan conversion system, comprising:

a spatial line averaging prefilter having a prefiltered signal as an output;

a motion estimator having the prefiltered signal as input and a motion-corrected signal as an output, the motion estimator comprising:

a 3-D recursive search sub-component having a bilinear interpolator;

a motion vector correction sub-component having an error function, the error function including penalties related to a length of the difference vector between a given candidate vector and a plurality of neighboring vectors;

a block erosion sub-component;

wherein the motion estimator assumes that a motion vector for an object between a previous field and a current field is the same as a motion vector for the object between the current field and a next field

a three-stage adaptive recursive filter having the prefiltered output and the motion-corrected output as inputs, the three stages comprising:

a first stage that comprises a function that selects between using static pixels data and moving pixels data from a next field;

a second stage that comprises a function that selects a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and

a third stage that comprises a function that combines an intra-field interpolation with the more valid set of data selected by the second stage.

31. An interlace-to-progressive scan conversion system, comprising:

a spatial line averaging prefilter having a prefiltered signal as an output;

a motion estimator having the prefiltered signal as input and a motion-corrected signal as an output, the motion estimator comprising: a 3-D recursive search sub-component; a motion vector correction sub-component; and a block erosion sub-component;

wherein:

the 3-D recursive search sub-component includes a bilinear interpolator defined by:

$$F(x,y,t) = (yf \cdot xf \cdot F(xi,yi,t)) + (yf \cdot (1-xf) \cdot F(xi+1,yi,t)) + ((1-yf) \cdot xf \cdot F(xi,yi+1,t)) + ((1-yf) \cdot (1-xf) \cdot F(xi+1,yi+1,t)$$

where:

$$yf = \lfloor y \rfloor \qquad xf = \lfloor x \rfloor$$

and:

$$yi = y - \lfloor y \rfloor \qquad xi = x - \lfloor x \rfloor$$

and wherein a value of a first estimator is set to a value of a second estimator if:

$$e(\overline{MV}_a, \overline{X} - \overline{SMV}_a, t) > e(\overline{MV}_b, \overline{X} - \overline{SMV}_b, t) + Th$$

and wherein the value of the second estimator is set to the value of the first estimator if:

$$e(\overline{MV}_b, \overline{X} - \overline{SMV}_b, t) > e(\overline{MV}_a, \overline{X} - \overline{SMV}_a, t) + Th$$

where Th is a fixed threshold;

the 3-D recursive search sub-component has a look-up table consisting of:

$$US_n = \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \begin{pmatrix} 0 \\ -1 \end{pmatrix}, \begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} -1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 2 \end{pmatrix}, \begin{pmatrix} 0 \\ -2 \end{pmatrix}, \begin{pmatrix} 3 \\ 0 \end{pmatrix}, \begin{pmatrix} -3 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ \frac{1}{4} \end{pmatrix}, \begin{pmatrix} 0 \\ -\frac{1}{4} \end{pmatrix}, \begin{pmatrix} \frac{1}{4} \\ 0 \end{pmatrix}, \begin{pmatrix} -\frac{1}{4} \\ 0 \end{pmatrix} \right\}$$

a motion vector correction sub-component having an motion vector error correction function defined by:

$$\overline{MV}(x,y,t) = \begin{cases} \begin{pmatrix} 0 \\ 0 \end{pmatrix}, & (e_m(x,y,t) \geq e_s(x,y,t)) \\ \overline{MV}(x,y,t), & (e_m(x,y,t) < e_s(x,y,t)) \end{cases}$$

where:

$$e_m(x,y,t) = \sum |F(C) - F(D)|$$

$$e_s(x,y,t) = \sum |F(A) - F(B)|$$

and where $\boldsymbol{A}$, $\boldsymbol{B}$, $\boldsymbol{C}$, $\boldsymbol{D}$, and $\boldsymbol{X}$ are blocks containing ends of candidate motion vectors, $\boldsymbol{X}$ being in the current field, $\boldsymbol{A}$ and $\boldsymbol{C}$ being in the previous field, and $\boldsymbol{B}$ and $\boldsymbol{D}$ being in the next field.

a block erosion sub-component that divides each block according to:

$$B(x,y,t) = \{(x,y) \mid X_x - X/2 \leq x \leq X_x + X/2 \wedge X_y - Y/2 \leq y \leq X_y + Y/2\}$$

wherein a vector $\overline{MV}(x,y,t)$ is assigned, into four sub-blocks $B_{i,j}(x,y,t)$

$$B_{i,j}(x,y,t) = \left\{(x,y) \mid X_x - (1-i)\cdot\frac{X}{4} \leq x \leq X_x + (1+i)\cdot\frac{X}{4} \wedge X_y(1-j)\cdot\frac{Y}{4} \leq y \leq X_y + (1+j)\cdot\frac{Y}{4}\right\}$$

and wherein the variables *I* and *j* take the values +1 and –1; wherein a vector $MV_{i,j}(x, y, t)$ is assigned to the pixels of each of the sub-blocks $B_{i,j}(x, y, t)$:

$$\forall(x,y) \in B_{i,j}(x,y,t) : \overline{MV}_{i,j}(x,y,t) = \overline{MV}_{i,j}(\overline{X},t)$$

wherein:

$$\overline{MV}_{i,j}(\overline{X},t) = \text{med}\left[\overline{MV}\left(x+i \cdot X, y, t\right), \overline{MV}(\overline{X},t), \overline{MV}(x, y+j \cdot Y, t)\right]$$

wherein the median function is a median on the *x* and *y* vector components separately; and wherein a resulting vector is replaced by an original motion vector unless the resulting vector is equal to one of the three input vectors.

a three-stage adaptive recursive filter having the prefiltered signal and motion-corrected signals as output, the three stages comprising:

a first stage comprises a function that selects between using static pixels data and moving pixels data from a next field according to the function:

$$F_n(x,y,t) = \begin{cases} F(x + MV_x(x,y,t), y + MV_y(x,y,t), t+1), & (D_m < D_s) \\ F(x,y,t+1), & (D_m \geq D_s) \end{cases}$$

where:

$$D_s = \sum_{k=-2}^{2} C_v(k) \cdot \left|F(x,y+k,t) - F(x,y+k,t+1)\right|$$

$$D_m = \sum_{k=-2}^{2} C_v(k) \cdot \left|F(x,y+k,t) - F(x - MV_x(x,y,t), y - MV_y(x,y,t) + k, t+1)\right|$$

a second stage comprises a function that selects a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and

a third stage comprises a function that combines an intra-field interpolation with the more valid set of data selected by the second stage according to the function:

$$F_o(x,y,t) = \begin{cases} F(x,y,t), & (y \bmod 2 = t \bmod 2) \\ (c_i \cdot F_i(x,y,t)) + (1-c_i)(c_p \cdot F_p(x,y,t) + (1-c_p)F_n(x,y,t)), & \text{(otherwise)} \end{cases}$$

wherein c_i and c_p are adaptive coefficients ranging from 0 to 1; F_n is given by:

$$F_n(x,y,t) = \begin{cases} F(x+MV_x(x,y,t), y+MV_y(x,y,t), t+1), & (D_m < D_s) \\ F(x,y,t+1), & (D_m \geq D_s) \end{cases}$$

wherein intra-field interpolation is given by:

$$F_i(x,y,t) = \frac{F(x,y-1,t) + F(x,y+1,t)}{2}$$

and wherein backward data prediction is given by:

$$F_p(x,y,t) = F(x-MV_x(x,y,t), y-MV_y(x,y,t), t-1)$$

32. A method for converting an interlaced image to a progressive scan image, the method comprsing:

providing an input signal corresponding to an image;

prefiltering the input signal with a spatial line averaging prefilter;

estimating motion in the image by:

performing a 3-D recursive search;

performing a motion vector correction;

performing a block erosion to reduce blockiness in the progressive scan image;

filtering the signal in three stages:

in the first stage selecting between using static pixels data and moving pixels data from a next field;

in the second stage selecting a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and

in the third stage combining an intra-field interpolation with the more valid set of data selected by the second stage.

33. A method for converting an interlaced image to a progressive scan image, the method comprsing:

providing an input signal corresponding to an image;

prefiltering the input signal with a spatial line averaging prefilter;

estimating motion in the image by:

assuming that a motion vector for an object between a previous field and a current field is the same as a motion vector for the object between the current field and a next field;

performing a 3-D recursive search;

performing a motion vector correction in which the error function penalizes a candidate vector based on a length of a difference vector between the candidate vector and a plurality of neighboring vectors;

performing a block erosion to reduce blockiness in the progressive scan image;

filtering the signal in three stages:

in the first stage selecting between using static pixels data and moving pixels data from a next field;

in the second stage selecting a more valid set of data between motion compensated data from a previous field and the pixels selected by the first stage; and

in the third stage combining an intra-field interpolation with the more valid set of data selected by the second stage.